

Claims

- [c1] 1. A method of quenching a material, comprising the steps of:
providing a material having a first section and a second section; and
propelling a fluid against said first section to increase a cooling rate of
said first section relative to a cooling rate of said second section.
- [c2] 2. The method as recited in claim 1, wherein said fluid comprises a gas.
- [c3] 3. The method as recited in claim 1, wherein said propelling step generally
minimizes a gradient between a temperature of said first section and a
temperature of said second section.
- [c4] 4. The method as recited in claim 1, wherein the propelling step comprises
impinging said fluid against said first section to provide impingement cooling at
said first section.
- [c5] 5. The method as recited in claim 1, wherein the propelling step remains
constant during quenching.
- [c6] 6. The method as recited in claim 1, wherein the propelling step varies during
quenching.
- [c7] 7. The method as recited in claim 6, wherein the propelling step varies by
adjusting a pressure of said fluid.
- [c8] 8. A method of adjusting the cooling rate of a forging during quenching,
comprising the steps of:
providing a forging having a first section with a first cooling rate and a
second section having a second cooling rate; and
propelling a fluid against said first section in order to minimize a
differential between said first cooling rate and said second cooling rate.
- [c9] 9. The method as recited in claim 8, wherein said fluid is a gas.
- [c10] 10. The method as recited in claim 8, wherein said propelling step generally
minimizes a gradient between a temperature of said first section and a
temperature of said second section.

- [c11] 11. The method as recited in claim 8, wherein the propelling step comprises impinging said fluid against said first section to provide impingement cooling at said first section.
- [c12] 12. The method as recited in claim 8, wherein the propelling step remains constant during quenching.
- [c13] 13. The method as recited in claim 8, wherein the propelling step varies during quenching.
- [c14] 14. The method as recited in claim 13, wherein the propelling step varies by adjusting a pressure of said fluid.
- [c15] 15. An apparatus for quenching a material, the material having a first section and a second section, said apparatus comprising:
a support for receiving the material; and
an outlet adjacent said support for impinging a fluid against the first section of the material, so that a cooling rate of the first section increases relative to a cooling rate of the second section.
- [c16] 16. The apparatus as recited in claim 15, wherein said outlet has a diameter (d) and is positioned a distance (Z) from the material placed in said support, and Z/d is between approximately 1.0 and 6.0.
- [c17] 17. The apparatus as recited in claim 15, wherein said outlet comprises a plurality of outlets each having a diameter (d), adjacent outlets having a spacing (s) therebetween, and s/d is less than approximately 26.0.
- [c18] 18. The apparatus as recited in claim 17, wherein said spacing is a circumferential spacing (X) and X/d is less than approximately 26.0.
- [c19] 19. The apparatus as recited in claim 17, wherein said spacing is a radial spacing (Y) and Y/d is less than approximately 24.0.
- [c20] 20. The apparatus as recited in claim 15, wherein said outlet comprises a plurality of outlets in an annular pipe.